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Development and Implementation of a Comprehensive Lake and Reservoir Strategy for Nebraska as a Model for Agricultural Dominated Ecosystems

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Workshop Abstracts

2000/2001 Aquatic Ecosystem Classification and Reference Conditions STAR Progress Review Workshop

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Introduction

The mission of the U.S. Environmental Protection Agency (EPA) is to protect public health and safeguard and improve the natural environment—air, water, and land upon which life depends. Achievement of this mission requires the application of sound science to the assessment of environmental problems and to the evaluation of possible solutions. The National Center for Environmental Research (NCER) at EPA is committed to providing the best products in high-priority areas of scientific research through significant support for long-term research.

The Office of Research and Development's (ORD) Environmental Monitoring and Assessment Program's (EMAP) goal is to build the scientific basis, and the local, state, and tribal capacity, to monitor for status and trends in the condition of the Nation's aquatic ecosystems. Research into the development of new and better classification systems has been identified by EMAP as essential to improving the current EMAP approach. The research presented at this progress review represents some of the extramural component of EMAP. You may find extensive information about the EMAP program at http://www.epa.gov/emap.

In 2000 and 2001, NCER issued a Request for Applications (RFA) on the Development of Aquatic Ecosystem Classifications and Reference Conditions. The purpose of these solicitations was to support research that led to the development of functional, defensible classification schemes and associated reference conditions for use in the application of biocriteria to one or more of the following aquatic resources: wetlands, large rivers, ephemeral systems, reservoirs, lakes, streams, estuaries, near-shore coastal environments, and coral reef communities. A total of 6 grants have been funded under this program.

Annual progress reviews such as this one will allow investigators to interact with one another and to discuss progress and findings with EPA and other interested parties. Although the research described in this report has been funded wholly or in part by the EPA, it has not been subjected to the Agency's required peer and policy review and therefore does not necessarily reflect the views of the Agency and no official endorsement should be inferred. Any opinions, findings, conclusions, or recommendations expressed in this report are those of the investigators who participated in the research. If you have any questions regarding the program, please contact the program manager, Barbara Levinson, at 202-564-6911 or levinson.barbara@epa.gov.

To learn more about EPA's STAR Program, visit NCER's Web Site at: http://www.epa.gov/ncer.

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In agriculturally dominated regions, land use practices have an unusually large impact on water bodies and, therefore, land use may reduce the utility of current ecoregion-based approaches to lake classification by dampening the signals that underlie the ecoregion framework. A team of water quality researchers has been assembled to develop a comprehensive classification scheme for agriculturally dominated ecosystems, using Nebraska as a highly representative model. Three objectives critical to achieving this goal are to establish: (1) a protocol for aggregating water bodies in agricultural ecosystems into classification strata and identifying reference conditions for these classes; (2) the role of remote sensing and the Geographic Information System in a classification strategy; and (3) a technology transfer link between the proposed classification system and end-users.

A water quality database for nearly 325 Nebraska lakes and reservoirs was established by sampling an additional 181 water bodies during the first 2 years of this project. All water bodies were sampled monthly from May through September for common limnological parameters (e.g., nutrients, clarity, chlorophyll). From this database, lakes and reservoirs are being classified hierarchically using a combination of rule-based and data-based approaches. For example, in the Sand Hills region of Nebraska, lake classes were defined by performing a factor analysis on the limnological data and plotting the significant factors to identify five groups of lakes with similar water quality characteristics. The factor analysis revealed that three significant factors explained more than 73 percent of the variability of the data, with alkalinity, conductivity, chlorophyll, nitrate+nitrite, Secchi depth, total suspended solids, orthophosphate, and total phosphorus loading significantly into the three factors. Interestingly, the Level IV Ecoregions based on soil type, native vegetation cover, topography, and geology do not accurately represent water quality in this region. Limited surface water inputs, combined with local hydrology, reduce the utility of landscape classification approaches in the Sand Hills region.

Improved methods also are being developed for integrating field data, data collected via airborne and close range remote sensing, data collected via operational and near future satellite remote sensing systems, and ancillary geospatial data in a multistage approach to lake classification. Biological indicators that integrate the lake conditions of each stratum will be developed from summer phytoplankton and zooplankton collections, and special emphasis has been placed on developing methods to remotely sense biological indicators of water quality based on the optical phytoplankton pigment structures of lakes. Algorithms for remote estimation of chlorophyll were developed and tested in close range remote sensing measurements in water bodies with different trophic status. The developed technique was very sensitive to even slight variation in chlorophyll concentration as well as in turbidity and Secchi depth. Standard error of chlorophyll concentration prediction was less than 5 mg/m^3 in the range of chlorophyll concentration from 10 to more than 194 mg/m^3 (see Figure 1). The technique also allows indication of presence of blue-green algae in water, although at this stage quantitative accuracy of the technique in phycocyanin estimation was not assessed. Measurements from aircraft (non-imaging) also showed high sensitivity of algorithms to chlorophyll and other optically active constituents.

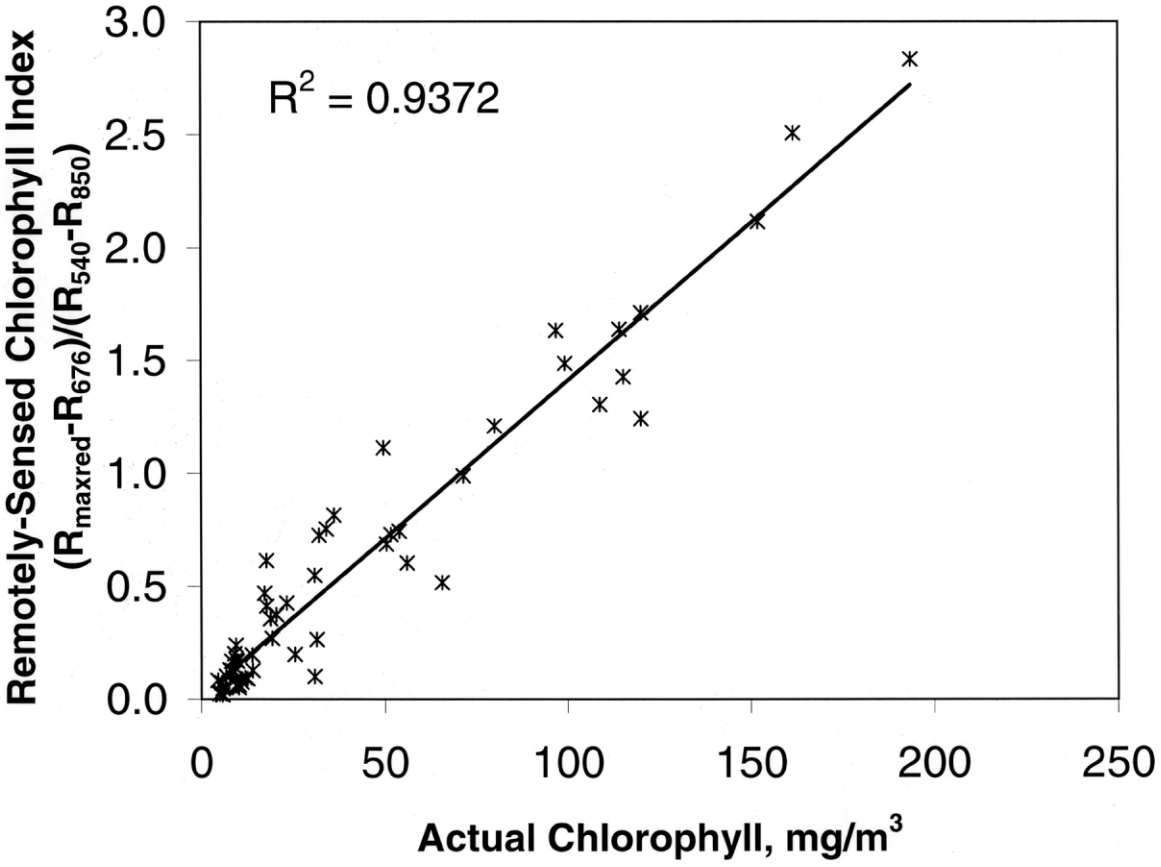

Figure 1. Actual chlorophyll concentrations versus an index of close-range, remotely-sensed chlorophyll concentrations in Nebraska lakes and reservoirs.